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BETTER BAGS FOR 85 YEARS

See page 25

...THE...

AMERICAN FERTILIZER

"That man is a benefactor to his race who makes two blades of grass to grow where but one grew before."

Vol. 99 OCTOBER 9, 1943 No. 8

The Use of Ammonium Nitrate in Mixed Fertilizers[1]

Division of Soil and Fertilizer Investigations, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, U. S. Department of Agriculture, Beltsville, Maryland

Introduction

EXPERIMENTS relating to the use of ammonium nitrate in mixed fertilizers constitute one of three phases of ammonium nitrate investigations being conducted in this laboratory. The results of studies on the improvement of the physical properties of ammonium nitrate have been given in a recent report (2)*. Investigations relating to certain agronomic phases of the use of ammonium nitrate are in progress.

This report presents data secured in a laboratory investigation on the influence of ammonium nitrate on moisture absorption by complete fertilizers. Most comparisons were made under three methods of formulation, namely, neutralization of the superphosphate with (a) Cyanamid or anhydrous ammonia, (b) Nitrogen Solution-2A, or (c) Urea-Ammonia Liquor-B. These represent the basic formulation practices of most fertilizer manufacturers. The effects of various controllable factors on moisture absorption will be evident from a study of the data which should be useful in formulating fertilizers with ammonium nitrate.

Literature

Fundamental data on the hygroscopicity of fertilizer salts have been reported by Adams and Merz (1), and Merz *et al* (4). Keenen (3) gives a good discussion of the several factors influencing the absorption of moisture by mixed fertilizers. Parker and Ross (5) recently presented some material relating to the use of ammonium nitrate in the formulation of fertilizers. Since these references give an adequate discussion of the principles involved in formulating fertilizers with one or more hygroscopic materials, this report will be limited to the presentation of experimental data.

Experimental Procedure

Several series of fertilizers, mostly 5–10–5, were prepared and the amount of moisture absorbed under controlled conditions of temperature and humidity was determined. The experiments were planned to show the influence on moisture absorption of the following variables in the fertilizer formula:

1. Source of ammonium nitrate.
2. Source of nitrogen; comparison of ammonium nitrate, sodium nitrate and urea.
3. Quantity of ammonium nitrate.
4. Source of potash; comparison of muriate, sulphate and manure salts.
5. Quantity of manure salts.
6. Potash content of the fertilizer, 0 to 10 units K_2O.

The 5–10–5 fertilizers were formulated with run-of-pile superphosphate, 200 pounds of dolomite and 100 pounds of an organic conditioner per ton. Unless otherwise indicated, the potash was from 62 per cent muriate. Sources of nitrogen were as indicated in the tables and figures, with ammonium sulphate to make the 5 units. All mixtures were made in 2000-gram batches and were allowed to cure 30 to 60 days. Representative samples were obtained and ground to pass a 40-mesh screen. Two-gram samples of these pulverized mixtures of known moisture content were then placed in thin layers in flat dishes and exposed

[1]The experiments reported were conducted by J. O. Hardesty, J. Y. Yee and V. L. Gaddy under the direction of W. H. Ross. The manuscript was prepared by J. O. Hardesty and F. W. Parker.

*Numbers in parentheses refer to literature listed at the end of the article.

to 59.4, 65.2 and 72.5 per cent relative humidity in closed metal chambers (12 inches in diameter and 7 inches high). Each chamber was equipped with a small fan to insure equal distribution of air over an appropriate saturated salt solution to give the desired humidity. The humidity chambers were housed in a constant temperature room operating at 86° F.

It should be noted that the sample was spread in a thin layer and that every portion was thus exposed to the humidified air to facilitate moisture absorption. Equilibrium between the sample and the air was reached in about 48 hours. This was determined by placing the sample in the humidity chamber and recording the hourly increase in weight until the weight was constant, indicating maximum absorption of moisture. The sample was then reweighed and the percentage moisture content determined.

Results

The experimental data are presented in seven tables and a portion of the material is also given in accompanying graphs. In studying the data attention should be given to the relative influence of different variables on moisture absorption.

As previously indicated the moisture contents reported are equilibrium values, obtained by exposing a very thin layer of the fertilizer to the indicated humidity at 86° F., a high summer temperature. Under these conditions the variation in the moisture content at 65.2 per cent relative humidity is probably the best index of the behavior of the fertilizer under field conditions. The relation of these laboratory data to factory and field problems of formulation will be considered in the discussion that follows presentation of the data.

Sources of Ammonium Nitrate.—In a recent year as much as 65,000 tons of ammonium nitrate from nitrogen solutions and Cal-nitro have been used in the manufacture of complete fertilizers (2). Many manufacturers, therefore, are somewhat familiar with its use in formulating different fertilizers. The question arises, however, as to whether different sources of ammonium nitrate have substantially the same or somewhat different effects on the properties of a fertilizer.

Table I shows the equilibrium moisture content of fertilizers containing two units of nitrogen as ammonium nitrate from five different sources, including ammonium nitrate granules coated with 0.5 per cent petrolatum-rosin-paraffin (PRP), a moisture repellent material, and 2 per cent kieselguhr. This series of mixtures was stored warm, 100° F., for 10 days before making the moisture absorption experiments. In this one series the samples were not ground after storage as that treatment would have destroyed any unaltered granules.

The data clearly indicate there is little or no difference between the various sources of ammonium nitrate as regards their influence on moisture absorption. An examination of the Cal-nitro granules showed that nearly all of the ammonium nitrate had diffused from the granule. The ammonium nitrate had also diffused from the PRP coated granules leaving hollow shells. While the source of ammonium nitrate did not influence moisture absorption in this series, that might not be the case if the

TABLE I

THE INFLUENCE OF THE SOURCE OF AMMONIUM NITRATE ON MOISTURE ABSORPTION BY 5–10–5 FERTILIZER

Source of 2 Units[1] Ammonium Nitrate	Moisture Content, per cent 59.4% R. H.	65.2% R. H.	72.5% R. H.
None	1.5	2.6	18.2
Fine crystals	3.4	10.0	22.4
Solution	4.6	9.9	20.8
Cal-nitro	3.5	8.9	22.7
TVA 1% petrolatum	3.4	9.2	21.5
Granular, uncoated	3.3	8.0	24.8
Granular, 0.5% PRP	3.4	8.6	24.4

[1]In this and other tables the term "units ammonium nitrate" is used to designate the units of nitrogen derived from ammonium nitrate. The same terminology is used for other materials.

ammonium nitrate were added to a cured base-goods at the shipping mill. Under those conditions the granular forms, particularly Cal-nitro and PRP coated granules, might give substantially different results than fine crystals or ammonium nitrate added in solution. Experiments on this method of formulation with different sources of ammonium nitrate are in progress.

Sources of Nitrogen.—Manufacturers are familiar with the use of sodium nitrate and, to a limited extent, urea in formulating mixed fertilizers. Ammonium nitrate, therefore, has been compared with those two nitrogen materials which also increase the hygroscopicity of fertilizers. In these experiments, 5–10–5 mixtures were made with four units of nitrogen from ammonium sulphate plus either anhydrous ammonia, Nitrogen Solution-2A, or Urea-Ammonia Liquor-B. The fifth unit of nitrogen was added as either solid ammonium nitrate, solid sodium nitrate, or solid urea, or as an additional quantity of ammonium sulphate. The moisture absorption data are given in Table II and Fig. 1.

In series A, sodium nitrate made the mixtures more hygroscopic at all relative humidities than did either ammonium nitrate or urea. The effect of ammonium nitrate was about the same as that of urea. All three of the indicated nitrogen sources increased moisture absorption as compared to ammonium sulphate at relative humidities of 65.2 and 72.5 per cent.

Sodium nitrate produced a more hygroscopic mixture when used with Nitrogen Solution-2A and Urea-Ammonia Liquor-B in series B and C than did either ammonium nitrate or urea. The two series show that it is better to supplement Nitrogen Solution-2A with additional ammonium nitrate than with sodium nitrate or urea. Likewise it is better

TABLE II

THE INFLUENCE OF DIFFERENT SOURCES OF NITROGEN ON MOISTURE ABSORPTION BY 5–10–5 FERTILIZER

Source of One Unit of Nitrogen	Moisture Content, per cent 59.4% R. H.	65.2% R. H.	72.5% R. H.
A. 1.25 units anhydrous ammonia, 2.75 units ammonium sulphate			
Ammonium nitrate	4.6	6.7	20.8
Sodium nitrate	6.6	12.4	26.1
Urea	5.1	7.5	19.3
Ammonium sulphate	4.8	5.0	9.1
B. 2.8 units Nitrogen Solution-2A,[1] 1.2 units ammonium sulphate			
Ammonium nitrate	4.9	9.3	20.7
Sodium nitrate	10.2	20.0	25.1
Urea	7.4	14.9	19.6
Ammonium sulphate	4.5	6.7	18.7
C. 2.25 units Urea-Ammonia Liquor-B,[2] 1.75 units ammonium sulphate			
Ammonium nitrate	5.2	11.2	19.0
Sodium nitrate	9.9	17.8	24.6
Urea	5.3	8.7	16.7
Ammonium sulphate	4.5	6.6	14.5

[1]Contains 1.57 units N as ammonium nitrate.
[2]Contains 1.0 unit N as urea.

to supplement Urea-Ammonia Liquor-B with additional urea than with sodium nitrate or ammonium nitrate. Trade experience, however, has shown that it is feasible to use ammonium nitrate (Cal-nitro) with Urea-Ammonia Liquor-B and urea (Uramon) with Nitrogen Solutions.

The experiments show that in the three types of fertilizer a unit of nitrogen from ammonium nitrate produces decidedly less-hygroscopic mixtures than an equivalent quantity of sodium nitrate. Other experiments with similar mixtures show that, when compared on an equal weight basis, ammonium nitrate produces less-hygroscopic mixtures than sodium nitrate. It appears, therefore, that manufacturers can use at least as much ammonium nitrate as sodium nitrate in their formulas. These comparisons have not included mixtures containing manure salts.

Quantity of Ammonium Nitrate.—The limits as to quantity of ammonium nitrate that could be used in a 5–10–5 were studied in three series in which the neutralizing agent was anhydrous ammonia, Nitrogen Solution-2A and Urea-Ammonia Liquor-B. In each series the quantity of ammonium sulphate was reduced as the ammonium nitrate was increased. The data are given in Table III and Fig. 2.

In the anhydrous ammonia series the use of increasing amounts of ammonium nitrate produced a gradual increase in moisture absorption at the two higher humidities. None of the mixtures is considered too hygroscopic for use under average conditions.

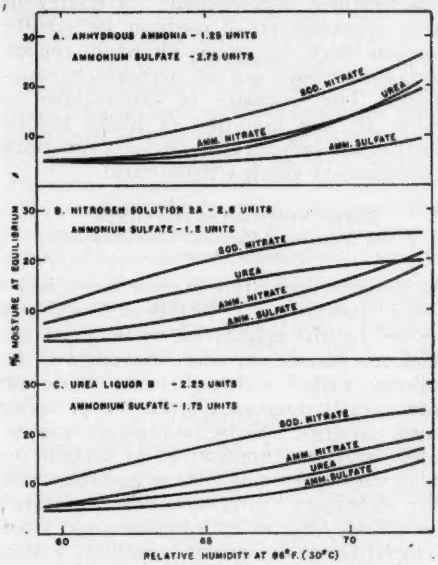

FIG. 1. The influence of 1 unit of different sources of nitrogen on the absorption of moisture by 5–10–5 fertilizer.

The Nitrogen Solution in series B carried 1.57 units of nitrogen from ammonium nitrate so that the mixture contained a total of 2.57 units from ammonium nitrate. Its moisture absorption is essentially the same as would be expected from the data of series A and the earlier observation that there was little or no difference in the influence of ammonium nitrate on moisture absorption when added in solution and as a solid.

Series C shows that the use of a unit of ammonium nitrate with Urea-Ammonia

(Continued on page 20)

The Boron Symposium

Abstracts of Papers Presented at the Meeting of the Division of Fertilizer Chemistry at Pittsburgh, Pa., September 6 to 10. 1943, H. B. Siems, Presiding. Abstracts of other papers from the Boron Session appeared in our September 25th issue.

The Use of the Spectrograph in Boron Research

Richard C. Nelson, Citrus Concentrates, Inc., Dunedin, Florida

The use of spectroscopic methods in boron research is most advantageous when information on the concentration of other elements in the same sample is of value, or when only very small quantities of material are available, as in the tracheal sap method. A quartz or grating spectrograph of medium or greater dispersion may be used, although replica grating instruments are not particularly satisfactory. The intensity of boron lines is affected by the quantity of alkali metals present in the sample, and special precautions are necessary to eliminate this effect.

Boron Nutrition of the Grape

L. E. Scott, University of Maryland, College of Agriculture, College Park, Md.

An abnormal condition in growth and fruiting of a vineyard on a Norfolk sand soil was corrected by the application of borax at the rate of ten pounds per acre. Severity of the deficiency varied widely between varieties. Boron greatly increased fruit set of reflex stamen varieties. Fruit production was increased by borax application in certain instances when there was little or no observable boron deficiency symptoms on untreated vines. Sand cultures with two-year-old vines developed boron deficiency symptoms within thirty days after growth inception and confirmed the field experiments. Leaves from fifteen varieties were analyzed for boron by the quinalizarin method at intervals during the growing season. The boron-calcium ratio in the leaf and stem tissue of normal and deficient vines was also determined.

Chemical and Biologic Studies on Aqueous Solutions of Boric Acid, Calcium, Sodium, and Potassium Metaborates

W. E. Colwell and R. W. Cummings, North Carolina State College of Agriculture, Raleigh, N. C.

Boron may exist in the soil as a mixture of several ionic species—orthoborates which are relatively unstable in aqueous solution, metaborates, and tetraborates. Low soil moisture and high pH favor condensation to metaborates and at the same time these are the conditions under which absorption of boron by plants is most likely to be reduced, especially if the calcium (or magnesium) content is high.

Conductivity measurements showed that the ionic conductance value for the boron-containing anion in aqueous solutions of sodium and potassium metaborate, and of sodium tetraborate was around 33 which agrees with the literature value for H_2BO_3, but the corresponding value for the calcium metaborate system was much lower. The former systems were stable but the calcium metaborate solutions underwent an "aging" process during which time conductance lowered and pH lowered towards neutrality.

Concentrations of boron as high as 650 p.p.m. B were obtainable from CaB_2O_4 when excess was allowed to remain in contact with water for 6 months, yet complete dissolving of a charge calculated to give 42.3 p.p.m. B was not attained after 41 days.

The absorption of boron by the sunflower from aqueous solutions of boric acid, calcium, sodium, and potassium metaborates and sodium tetraborate was a function of time of contact and concentration and not the source.

Mineral Nutrition with Particular Reference to Boron

F. B. Chandler, Maine Agricultural Experiment Station, Orono, Maine

The symptoms of boron deficiency in *Brassica* which have been observed in the greenhouse and field are presented. The effect of different kinds of sand, amounts of boron, calcium, and potassium in the nutrient solution on the growth and boron deficiency symptoms in broccoli are discussed. An association between boron deficiency and stem-end browning in potato tubers is presented.

The Effect of Boron Deficiency on Cellular Structure and Behavior Principally of the Swede Turnip

John G. Coulson, Macdonald College of McGill University, Macdonald College, Quebec, Canada

The anatomical disturbances induced in a number of plants by an insufficiency of boron have been studied.

An abnormal tissue composed essentially of thin-walled, radially elongated cells formed between the phloem and xylem in the vascular bundles of the leaves of swede turnips grown in sand culture with subminimal supplies of

(Continued on page 24)

Pasture Notes

Compiled by R. H. Lush, Pasture Specialist, the National Fertilizer Association

Use Fertilizers for Increasing Feed Production. "In view of large numbers of livestock units, there is a need for better feed-livestock balance. Fertilizers when applied to pastures will give the largest returns in feed units, as compared to other field crops. These fertilizers could well be used as top-dressing on permanent pastures or fall seeded annual crops, as small grains, that are to be used for supplementary pastures. Nitrogen fertilizers are especially valuable for increasing the production of annual crops. The use of nitrogenous fertilizers, either alone or in mixed fertilizer, must of course follow the recommendations of your own experiment station," says O. S. Fisher, senior agronomist, Extension Service, and M. A. Hein, senior agronomist, Division of Forage Crops and Diseases, U. S. D. A.—July 13, 1943, letter to State agronomists.

Emergency Feed Recommendations. "Provide abundant pasture. Use fertilizer on pasture in accordance with State recommendations," was among 14 sound suggestions made by the American Dairy Science Association meeting at Columbia, Missouri, June 22nd–24th. The 8-point program of the War Food Administration and the Dairy Industry Committee, which also stressed pasture and forage production, was endorsed.

ALABAMA

Grazing Crops Help Save Feed. A pasture program is not complete without supplementary grazing crops to carry livestock. Farmers can supply supplementary grazing crops by fertilizing established stands of kudzu and sericea, by planting small grains and crimson clover, and by planting Caley peas in the Black Belt with ample phosphate for grazing in late winter and early spring, suggests J. C. Lowery, extension agronomist.

ARKANSAS

Graze Oats. To obtain as much feed as possible under present conditions a mixture of adapted spring and winter varieties should be seeded early in September and, in case no phosphate or nitrogen has been applied to the previous crop, fertilized with 200 pounds of a complete 4–12–4 fertilizer per acre, advise H. R. Rosen and C. K. McClelland, agronomists, University of Arkansas.

CALIFORNIA

Nitrogen for Irrigated Pastures. The use of 200 pounds of nitrogen fertilizer per acre on 200 acres of mixed grass and legume pastures of the Lucas Ranching Company, near Chino, gave at least four-fold increased growth. This has aided greatly in solving the current feed shortage problem according to Don Nyberg, superintendent.—Pacific Rural Press, June, 1943.

FLORIDA

Improve Pasture with Fertilizer. Data show that cattle on native (wire) grass put on only 10 pounds of beef per acre as compared with 137 pounds on carpet grass, 178 pounds on Bermuda, 198 on Bahia, 300 on Napier, and 500 pounds on clover and carpet grass mixed. Fertilizer produced better mineral balance and was profitable on improved pastures. Maximum results in pasture improvement and maintenance are only obtained where the necessary calcium, phosphorus, potassium, and nitrogen are applied, says W. E. Stokes, agronomist.

GEORGIA

Annual Pastures Pay, Too. Ten years' results show an average production of 321 pounds beef per acre for completely fertilized lowland permanent pastures as compared to only 76 pounds where no fertilizer was used. Fertilized Tift Bermuda grass averaged 231 pounds gain per acre for two years. Kudzu averaged 250 pounds gain per acre for 7 years, as compared to 144 pounds for cat-tail millet. The 7-year average of oats and hairy vetch as winter pasture was 150 pounds gain per acre; for abruzzi rye, 107 pounds; for oats following common lespedeza, 89 pounds; and for ryegrass, 62 pounds per acre. A year-round grazing system has also been developed for hogs.—Ga. Coastal Plain Exp. Sta. Bul. 35.

ILLINOIS

Sheep Production Improved. At the Dixon Springs Experiment Station 4-year results on sheep show, for treatment with lime and phosphate, and intensively grazed, 12 pounds gain per acre; for lime and phosphate with regulated grazing, 144 pounds per acre; without soil treatment and intensively grazed, minus 11 pounds an acre; and without soil treatment but regulated grazing, 68 pounds

gain per acre. At average prices the soil treatment would pay for itself in a 2-year period and, in addition, improve the quality of grazing and reduce the run-off of water and soil.—Jour. Amer. Soc. Agron., Vol. 35, No. 4.

INDIANA

Save Protein and Feed. An acre of good alfalfa, clover, or rape pasture will carry 15 to 20 full-fed hogs from weaning to market. These will go to market each weighing 200 pounds on 15 to 20 bushels less grain and 400 to 600 pounds less protein supplement than similar hogs full feed in dry lot. With home-grown corn at 80 cents a bushel and protein supplement at $4.00 a hundred pounds, an acre of good pasture is worth from $30 to $40. While alfalfa or clover and grass mixtures are most desirable, rape, lespedeza, sudan, soybeans, or straight cereal pastures are desirable at certain seasons suggest M. O. Pence and C. M. Vestal, Purdue University.—Ind. Farmers' Guide, June 15, 1943.

KANSAS

Sod-Bound Condition Overcome with Nitrogen. In these times of nitrogen abundance and feed shortage, a test conducted by Dr. H. E. Myers and Kling L. Anderson on "sod-bound" bromegrass growing on supposedly fertile clay loam soil may have wide application. The use of 40 pounds per acre of nitrogen as ammonium sulphate on different plats gave an average increase in yield of grasses of 49 per cent for the use of nitrogen. The authors suggest that a search be made for deficiencies in soil fertility as possible casual factors responsible for "sod-bound" conditions observed under a variety of soil conditions.—Jour. Amer. Soc. Agron., Vol. 34, No. 8.

KENTUCKY

Seed Fall Feed Crops. The urgent need of sowing small grain and other pasture and feed crops like rye, wheat, winter barley and oats, alfalfa, crimson clover, and vetch during the next few weeks is stressed by Dean Thomas P. Cooper. "In face of the demand for food, every acre possible should be seeded to small grains and other feed crops. Until the war is over, we will need all the meat, milk, and eggs that it is possible to produce."

MAINE

Production Quadrupled. Unfertilized native pasture at Highmoor Farm averaged for 5 years 816 pounds milk per acre, as compared to 3351 pounds where liberal amounts of complete fertilizer were used each year. The vegetation from the liberally fertilized paddocks carried almost three times as much phosphorus, nearly twice as much protein and potash, almost 50 per cent more calcium and magnesium, and only about one-half as much silica or insoluble ash as that from unfertilized paddocks, reports D. S. Fink, former agronomist.—Maine Agr. Exp. Sta. Bul. No. 415.

MASSACHUSETTS

Fertilized Ladino Pastures Best. Grazing records of farms in Worcester and Middlesex Counties for 1942 showed an average of 6,114 pounds milk for Ladino clover, 3,940 pounds milk for other clovers and grass, and only 839 pounds for native grass pastures. When present costs for seed, lime, liberal amounts of fertilizer, and labor on Ladino pastures were calculated and deducted from the value of milk actually produced, the net return per acre was about $60. For clover and grass pastures this return was about $45, and for native pastures only $10 per acre when grain and hay costs were deducted. Annual crops of millet and sudan grass and of oats and rye averaged 2,526 pounds milk per acre with a net return of $25. Fertilizer gave excellent returns when amply applied on all grazing crops, reports Charles B. Creek.—New England Homestead, June 26, 1943.

MICHIGAN

Ladino Very Productive. Ladino clover seeded with an application of 500 pounds of superphosphate per acre at the Upper Peninsula Experiment Station gave 134 cow days grazing at a net return of $66.72 an acre where milk was valued at only $2 per hundredweight. A total of 5,771 pounds dry matter per acre averaging 23.3 per cent of crude protein was harvested from caged areas during the same season.—Mich. Quart. Bul., Vol. 25, No. 4.

MISSOURI

More Beef—Less Labor—Save Soil. An average of 265 pounds of beef per acre was produced annually on the wheat-lespedeza grazing areas at the Soil Conservation Experiment Farm, McCredie. This is the equivalent in corn production of 41 bushels per acre on what could be classed as 20 to 25 bushel corn land, the chief item of expense being for seeding wheat and for commercial fertilizer. This and other similar systems serve a triple purpose of producing cheap meat, saving labor, and helping to control erosion, states W. H. Colman, soil conservationist.

NEBRASKA

Nitrogen Increased Bromegrass Production. In replicated tests on different strains of bromegrass at Lincoln the application of 50 pounds of nitrogen per acre increased forage

yields, protein content of vegetation, and seed production by an average of 83 pounds per acre for all strains in 1942, report L. C. Newell and F. D. Keim.—Jour. Amer. Soc. Agron., Vol. 35, No. 5.

NEW JERSEY

Rotational Grazing Aid to Fertilizer Use. In a 4-year cooperative test on Dutchess stony loam soil at Sussex, rotational grazing with fertilizer application doubled the yield as compared to continuous grazing without fertilizer. The average annual animal gain per acre in the fourth year of the test was 451 pounds for the plot rotationally grazed and fertilized, 411 for that continuously grazed with fertilizer, 260 for that continuously grazed without fertilizer, and only 229 for that rotationally grazed without fertilizer. All methods gave good control of soil losses according to J. L. Haynes and O. R. Neel.—Jour. Amer. Soc. Agron., Vol. 35, No. 3.

NEW YORK

Fertilize Liberally. In the Catskill-Mohawk area, where the acreage of pasture is greater than that of all the harvested crops combined, best results follow if about 600 pounds of superphosphate are applied every 4 years. Unmanured, sandy soils and some silt loams will respond to the use of potash. Surface application is generally practised on permanent pastures, but whenever land is being seeded lime and phosphorus, and potash if needed, should be used liberally and worked into the soil during seedbed preparation, suggests Dr. A. F. Gustafson.—Cornell U. Agr. Exp. Sta. Bul. No. 789.

OHIO

Fifty Per Cent More Feed. Present pastures will readily produce 50 per cent more forage if applications of lime and fertilizer are used to promote growth of desirable grasses and legumes, says Dr. D. P. Dodd, extension agronomist. Reseeding is not necessary if desirable types of herbage make up 5 per cent or more of the plant growth present.—The Ohio Farmer, July 17, 1943.

ONTARIO

Fertilizing and Seeding Profitable. An average of 7 years' results at the Ontario Agricultural College on a 40-year-old pasture showed 1,200 pounds dry matter per acre with no treatment; 2,000 pounds dry matter per acre when 64 pounds phosphoric acid and 100 pounds K_2O were added as top dressing; and 3,250 pounds dry matter when complete fertilizer was used with over six times as much protein production per acre as on the untreated plot. When one of the completely fertilized plots was plowed and reseeded the resulting yield was 8,150 pounds dry matter per acre; a similarly fertilized plot, summer fallowed and reseeded, yielded 9,100 pounds dry matter per acre. Thus yields of dry matter were over 2.5 times more than the heavily fertilized natural pasture with 4 times the total yield of protein per acre, and over 7 times the yield of dry matter produced on the unfertilized plot of old bluegrass pasture, reports N. J. Thomas.—Farmers Digest, June, 1943.

OREGON

Use Low Protein on Pastures. Dairy cows having access to good pasture produced just as efficiently on a grain mixture containing 9.6 per cent digestible protein as when fed a grain mixture containing 12.3 per cent digestible protein. When 1,100 to 1,200 pound cows are grazing on irrigated Ladino clover and grass pasture they obtain 65 to 75 per cent of their necessary feed from pasture when producing approximately 40 pounds of 4 per cent milk daily, stated Prof. H. P. Ewalt.—Ore. Inf. Circ. No. 310.

SOUTH CAROLINA

Calcium and Phosphorus Aid Coastal Pastures. As an average of 3 years at Summerville, 51.6 pounds beef were produced per acre from untreated pastures; 64.6 pounds beef where 1 ton of lime was used each third year; and 97.4 pounds beef where 250 pounds of 16 per cent superphosphate was used annually in addition to the lime. The net pasture value per acre was more than twice as high for the treated pasture as that receiving no treatment. Burning pasture annually was not beneficial.—Fifty-fifth An. Rpt. S. C. Exp. Sta.

TENNESSEE

Seed Rye and Crimson Clover. In a 4-year test at the Middle Tennessee Experiment Station, Balbo rye and crimson clover, seeded September 1, furnished a total of 273 steer days of grazing up to May 15; barley and crimson clover, 242 steer days; and crimson clover alone only 207 steer days, according to L. R. Neel, superintendent.

TEXAS

Temporary Pastures Pay. Cows on pasture save the labor and expense of harvesting, hauling, and grinding of feed crops. Tem-

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Principal Articles in This Issue

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WFA Urges Early Buying and Delivery of Fertilizer

The War Food Administration is urging farmers to help in making the 1943–44 distribution of fertilizer fully effective by making immediate application for mixed fertilizers needed now and next spring and accepting delivery during fall and winter months.

WFA officials, in charge of the fertilizer program, stress that farmers can expect to have an adequate supply of fertilizer during the 1943–44 crop season by applying for it and taking delivery as soon as possible, thereby making it possible for manufacturers and dealers to deliver fertilizer over a long period. In all, it is expected that between 10 and 12 per cent more chemical fertilizer will be available to farmers in the 1943–44 crop season than during the past season, when farmers used a record 10.5 million tons.

Because of transportation, labor and storage difficulties, it is necessary to keep mixed fertilizer moving, if manufacturers are to meet farmers' needs. Manufacturers must receive supplies, mix the fertilizer and ship the finished product simultaneously. They have been taking supplies for production on the 1943–44 program since July 1, and the mixed goods have been building up in storage. This situation makes it necessary to take measures to avoid peak labor loads in the fertilizer plants, to prevent over-loading of transportation facilities, and to relieve the storage situation. Making application for fertilizer and accepting delivery of mixed fertilizer now will prevent such congestion.

Under the fertilizer distribution program, farmers are required to make application with their local dealers for the fertilizer they need. They can do this for mixed fertilizer they need this fall and for use next year.

Farmers, when accepting early delivery of mixed fertilizer should have no difficulty in storing it on their farms. Mixed fertilizer should preferably be stored in a dry, floored, weather-proof building. If the available storage space has no floor, a raised platform, which can be built of materials on hand, should be provided. Fertilizer should also be stored in the sacks it comes in, and not piled more than 8 to 10 sacks deep.

Obituary

WILLIAM J. GRAY

The fertilizer industry has lost another outstanding executive through the death of William Jarrell Gray, vice-president, in charge of sales, of Armour Fertilizer Works, on September 27th at the Piedmont Hospital in Atlanta, following a short illness. He was 55 years of age.

"Bill" Gray, as he was known affectionately to his associates and friends, spent his entire adult life in the fertilizer industry. He was a native of Maryland and began work for Armour Fertilizer Works in Baltimore thirty-five years ago. He was successively manager at Baltimore, manager at New York, general Eastern manager, and in April, 1934, went to Atlanta as vice-president, in charge of sales.

Mr. Gray always took an active part in industry affairs and was a regular attendant at the meetings of the National Fertilizer Association. For several years he was a member-at-large of the Soil Improvement Committee.

Surviving are his wife; two sisters, Miss Louise Gray and Mrs. Wesley E. Thawley, of Denton, Md.; and a brother, Thomas Gray, of Goldsboro, Md.

Changes In Official Grades Announced

M. K. Derrick, of the Fertilizer Division of WFA, has advised that at a recent meeting of the Fertilizer Industry Advisory Committee a number of recommendations were made relative to grade changes in some states. The recommendations were accepted and the grade changes will be formally announced in a re-issue of FPO-5 Revised, in the very near future. These changes are as follows:

1. 13–0–0 by-product nitrate of soda added to grades applicable to all states.
2. 5–8–7 in New Jersey only.
3. 6–8–4 in Virginia and North Carolina.
4. 3–9–6 restricted to tobacco only in Virginia and North Carolina.
5. 4–10–4 in Virginia, North Carolina, South Carolina, and Georgia.
6. 4–8–8 restricted to Group A crops only, and 3–9–9 restricted to tobacco only, in Georgia.
7. 4–8–12 eliminated from Louisiana and Texas.
8. 4–10–0 replaces 3–10–0 in Texas.
9. 5–10–5 added for Oregon, Washington, and Idaho.

The 13–0–0 by-product nitrate of soda will probably be allocated to a few states only.

Sulphate of Ammonia During August

The figures of the U. S. Bureau of Mines show that sulphate of ammonia production during August increased about 5 per cent over July, showing a total tonnage of 65,486. Production for the first eight months of the year is still about 1½ per cent behind the same period for 1942. Under the allocation plan, shipments have continued at a steady level for the past few months, while stocks on hand at the producers' works remain fairly constant at about 40,000 tons. This is somewhat less than comparative figures for the same period last year.

	Sulphate of Ammonia Tons	Ammonia Liquor Tons, NH_3
Production		
August, 1943	65,486	2,899
July, 1943	62,257	2,878
August, 1942	64,076	2,806
January–August, 1943	505,170	22,730
January-August, 1942	512,244	22,337
Shipments		
August, 1943	62,960	2,967
July, 1943	61,725	2,961
August, 1942	68,444	2,812
Stocks on Hand		
August 31, 1943	42,407	1,028
July 31, 1943	40,034	957
August 31, 1942	58,148	850
July 31, 1942	62,654	711

New Booklets Tell How to Care for Buckets in Wartime

The Hayward Company, 50 Church Street, New York 7, N. Y., announce the publication of three new booklets on the care of Hayward Orange Peel, Clam Shell, and Electric Motor Buckets. Although these wartime guides are particularly intended for users of Hayward products, they contain a wealth of timely information and helpful suggestions that will prove invaluable in the proper care and maintenance of practically any make of bucket.

In each booklet the reader is reminded of the importance of (1) correct bucket lubrication at proper intervals, (2) frequent inspection of wearing surfaces and parts, (3) the advantage of promptly replacing worn parts before they weaken or impair the whole bucket structure, and (4) the greater operating effi-

ciency obtained by keeping moving parts in proper adjustment.

Good bucket care is emphasized as today's best insurance for better, longer bucket service. In as much as buckets are made of critical, urgently needed metals, good care not only promotes longer bucket life but also contributes to essential conservation. It keeps costly replacements at a minimum and plays a significant role in speeding the final Victory.

Copies of each booklet are obtainable without cost from the manufacturer.

September Tax Tag Sales

Fertilizer tax tag sales in September in 17 reporting states represented 310,000 equivalent tons, compared with 231,000 tons a year ago, and 204,000 tons two years ago. The high level of sales this year represents in part the large demand for fertilizer for use this fall and in part the buying of tags for use in 1944. The increase in sales over last year is widespread, with 15 of the 17 states reporting increases.

Sales in 16 out of 17 of the reporting states were larger in the first nine months of this year than last. The increase in aggregate sales in the 17 states over January–September, 1942, was 14 per cent; the increase over 1941 was 16 per cent.

This is the fifth consecutive year in which an increase in fertilizer consumption has taken place. Tonnage used in 1943 is substantially larger than in any preceding year. In addition, the plant food content of fertilizer is higher this year than it has ever been.

FERTILIZER TAX TAG SALES

State	September 1943 Tons	September 1942 Tons	September 1941 Tons	% 1942	January–September 1943 Tons	January–September 1942 Tons	January–September 1941 Tons
Virginia	47,383	34,021	44,116	107	400,265	374,239	362,194
North Carolina	39,076	29,677	19,222	105	1,133,561	1,076,264	1,014,873
South Carolina	15,015	10,900	5,040	115	715,783	622,194	677,587
Georgia	17,674	15,518	5,513	120	894,503	747,468	751,634
Florida	48,234	41,880	32,665	119	538,205	453,138	433,516
Alabama	8,650	3,950	1,800	113	631,700	559,700	565,000
Mississippi	8,500	4,962	1,675	133	387,544	292,029	323,617
Tennessee	12,700	9,563	1,363	129	205,353	159,743	128,338
Arkansas	4,300	3,850	350	121	161,275	133,158	113,100
Louisiana	33,500	7,550	11,600	125	178,688	142,986	160,510
Texas	15,823	7,176	11,095	125	146,950	117,294	129,226
Oklahoma	500	986	800	201	17,588	8,747	10,600
Total South	251,355	170,033	135,239	115	5,411,415	4,686,960	4,670,195
Indiana	22,460	34,171	32,939	99	379,990	385,104	332,537
Illinois	7,349	6,418	7,162	108	84,093	78,196	59,608
Kentucky	11,705	9,525	9,235	108	147,206	136,352	114,112
Missouri	12,786	7,675	15,539	126	88,046	69,924	86,039
Kansas	4,300	3,605	3,925	143	16,204	11,365	17,786
Total Midwest	58,600	61,394	68,800	105	715,539	680,941	610,082
Grand Total	309,955	231,427	204,039	114	6,126,954	5,367,901	5,280,277

FERTILIZER MATERIALS MARKET

NEW YORK

Adequate Supplies of Sulphate of Ammonia Expected for Coming Season. Treatment of Ammonium Nitrate Aids Fertilizer Use. Scarcity of Phosphates in Some Parts. Imported Tankage Used Entirely for Feed.

Exclusive Correspondence to "The American Fertilizer"

NEW YORK, October 5, 1943.

Sulphate of Ammonia

Deliveries against previous allocations have been moving steadily in good volume. Last week the situation was eased considerably by new allocations of sulphate of ammonia for November–June period and it is anticipated that sufficient inorganic ammonia will be available to satisfy the demands. It is understood that some of the fertilizer manufacturers are not taking advantage, at this time, of the new allocation of sulphate of ammonia as they have used large quantities of ammonia liquors and will not need additional sulphate of ammonia unless the supply of liquors decreases.

Nitrate of Soda

This material has also moved steadily against previous allocations and the October price remains the same as for previous months.

Ammonium Nitrate

Special treatment of this material has helped considerably and it is understood that fertilizer manufacturers are finding the use of this material less difficult than originally expected.

Potash

There has been no change in this situation and from all indications potash will be in continued demand throughout the season with buyers hopeful that additional allocations can be made for the deliveries of larger tonnages.

Superphosphate

This material continues in great demand with a real scarcity of phosphates in certain parts of the country. Practically no triple superphosphate is available for delivery to domestic fertilizer manufacturers over the balance of this year but it is anticipated that considerable quantities will be released for the domestic manufacturers for the January–June 1944 period, which should help the situation.

Tankage

Whereas deliveries from South America have increased considerably and with indication that these deliveries will be continued, all the importations are being used in the feed industry so that the scarcity of organic ammonia for fertilizer manufacturers is not affected.

BALTIMORE

Added Quantities of Sulphate of Ammonia and Nitrate of Soda Allocated to Manufacturers. Potash About Adequate for Normal Requirements.

Exclusive Correspondence to "The American Fertilizer"

BALTIMORE, October 5, 1943.

During the past two weeks the announcement of increased allocations of sulphate of ammonia and nitrate of soda to fertilizer manufacturers was the outstanding feature, and was well received by the trade.

Ammoniates.—The demand for organic ammoniates for feeding purposes is much greater than the supply, with the result that all this material is now being used for feed at a higher ceiling than exists on fertilizer material.

Castor Pomace.—Producers of castor pomace took care of their regular trade, and there have been practically no outside sales at \$2.90 per unit of ammonia (\$3.52½ per unit N), f. o. b. producers' shipping points, in bags. In fact the larger part of the production has been sold, but additional supplies will doubtless come to light from time to time as production increases.

Sulphate of Ammonia.—The Government has increased allocation of this ingredient for agricultural use from November to June inclusively, which would relieve all fertilizer manufacturers who were unable to figure any other way to increase their production as requested by Government bureaus for the coming year. The market remains unchanged

and the above news was heartily welcomed by the trade as a solution to one of the many problems facing manufacturers of complete fertilizer. There will probably not be any change in the market during the coming season, but buyers will be expected to take equal monthly deliveries.

Nitrate of Soda.—This material was also substantially increased by allocation during the month of October, with prospect of a similar situation prevailing throughout the coming season.

Superphosphate.—No stocks of superphosphate are accumulating, as none of the manufacturers are running to capacity due to inability to secure allocation of additional tonnage of sulphuric acid which is evidently required in other directions for more essential National Defense purposes.

Fish Meal.—The fishing season is practically over and last sales were reported at $72 per ton, in bulk, with allowance of $3 for grinding and $3 for bagging, which puts it out of the class of fertilizer material. This condition will probably exist for the duration.

Potash.—It is estimated that domestic production is able to take care of normal requirements, and that practically all manufacturers have covered for the major portion of their wants. Some buyers would like to secure additional supplies, but without success up to the present time. It is not a question of price, but of securing the goods.

Bone Meal.—The market continues quiet and unchanged with both 4½ and 47 per cent raw bone meal and 3 and 50 per cent steamed bone meal quoted at $50 per ton, in bags, f. o. b. Baltimore.

Bags.—It is still impossible to secure permit to use burlap for shipment of fertilizer, but bag manufacturers are hoping this situation will be changed within the near future.

CHARLESTON

Nitrogenous Supplies Short. Larger Production of Superphosphate Expected for Coming Season. Cottonseed Meal Going Entirely to Feed.

Exclusive Correspondence to "The American Fertilizer"

CHARLESTON, October 4, 1943.

Nitrogenous.—One of the producers has notified their customers that they would have to reduce their contracts 20 per cent in tonnage. There are still no further offerings of this material.

Castor Pomace.—This material is moving as fast as available, but actual sales are only to old customers at OPA fixed prices.

Dried Blood.—No change in this situation, market still $5.53 per unit of ammonia ($6.71 per unit N) f. o. b., Chicago, Ill.

Superphosphate.—It is now hoped that the total production for 1943–44 will be about 7,000,000 tons.

Bags.—No announcement has yet come out from Washington as to any release of burlap for the fertilizer manufacturers.

Cottonseed Meal.—Prices on the 8 per cent grade are: Georgia, $49.50; South Carolina, $50. All is going to feed mills, and these plants throughout the South are in a critical condition, due to their inability to secure sufficient oil seed meals.

CHICAGO

Lowered Ceiling Prices on Process Tankage and Sewage Sludge Announced. Feed Demand Continues at Maximum Levels.

Exclusive Correspondence to "The American Fertilizer"

CHICAGO, October 4, 1943.

The long-looked-for price roll-back on process tankage and sewage sludge was announced as of September 17th. The maximum roll-back on process tankage was 15 cents per unit ammonia at Midwestern producing points. Whether this price reduction will curtail the tonnage, as claimed by some pro-

ducers, remains to be seen. In any event, such offerings which come on the market are quickly absorbed.

There seems to be no let-up in the demand for feed, and consequently the materials market is well sold up at full ceiling prices.

No change in ceiling prices on other ammoniates has occurred.

High grade ground fertilizer tankage, $3.85 to $4.00 ($4.68 to $4.86 per unit N) and 10 cents; standard grades crushed feeding tankage, $5.53 per unit ammonia ($6.72 per unit N); blood, $5.38 ($6.54 per unit N); dry rendered tankage, $1.21 per unit of protein, Chicago basis.

TENNESSEE PHOSPHATE

Shipments of Phosphates Increasing to Limits of Manpower and Equipment. Considerable Activity in Phosphate Land Transactions.

Exclusive Correspondence to "The American Fertilizer"

COLUMBIA, TENN., October 4, 1943.

Beautiful fall weather for which this section is so noted has prevailed lately, and farmers and miners are well along with their work so far as the limited manpower permits. The alfalfa field, mentioned early last spring as having been top dressed with finely ground phosphate rock because it had come through the winter so badly as to cause the owner to contemplate plowing it up, excites the admiration of everyone by the fourth crop now knee high and most luxuriant in appearance while the first three cuttings, despite the terrific drouth, yielded 26 big loads from the five acres. Everyone admits that applying any kind of phosphate to this high phosphorous land ought not to do any good, but every time a farmer uses finely ground phosphate as a carrier for his tobacco poison, top dresses an old pasture or a legume seeding, he seems to get these good results.

Shipments of ground phosphate rock to farmers have been in as heavy volume the past two months as the supply of phosphate and manpower for bagging and loading permit, but it has been absolutely impossible to ship all of the enormous volume of orders, which always reach the largest peak in August, September and well into October.

Shipments into all other consuming channels, principally, of course, unground rock, are likewise proceeding at a lively pace and there is no visible indication as yet of the stockpiles generally accumulated during late summer and fall for the winter season of more difficult mining.

Considerable activity is still evident in the optioning and investigating of additional reserves by many of the large operators in Maury and nearby counties, as the enormously increased rate of shipment and use of phosphate make much more rapid inroads on these reserves.

Phosphate interests centering here are not so enthusiastic in their support of the general effort to secure lower freight rates for the South now on foot, since they enjoy commodity rates and those complained of are generally class rates. There is an uncomfortable fear that success in getting lower class rates, might do away with the commodity rates and the phosphate rates thereby be increased instead of lowered.

There has been no further development, so far as is known, in the suggested installation of a plant for defluorinating phosphate rock in order to supply a product to supplement the present scarcity of bone products for livestock mineral supplement. The International Minerals and Chemical Corporation is operating three plants for defluorinating superphosphate on which the OPA ceiling of $30 per ton is reported as having been recently increased. Meantime the large manufacturers, who have been using the regular ground rock from Tennessee for twenty years in this work, continue to do so.

THE USE OF AMMONIUM NITRATE IN MIXED FERTILIZERS

(Continued from page 7)

Liquor-B causes a considerable increase in moisture absorption, particularly at 65.2 per cent relative humidity. The use of a second unit produces a small additional increase in moisture absorption.

Source of Potash.—The source of potash used in formulating the 5–10–5 fertilizers greatly influences their absorption of moisture, as indicated by the data of Table IV. In the absence of ammonium nitrate, series A moisture absorption was low in all cases except with manure salts at 72.5 per cent relative humidity. When there were two units of nitrogen from ammonium nitrate in the mixture moisture absorption was low when potash was derived from sulphate of potash or sulphate of potash-magnesia. The muriate gave a considerably more hygroscopic mixture. The combination of ammonium nitrate and manure salts produced a very hygroscopic mixture at both 65.2 and 72.5 per cent relative humidity. It is evident from these data that the necessity of using manure salts makes it more difficult to use ammonium nitrate. The use of various quantities of manure salts was, therefore, studied in more detail.

Quantity of Manure Salts.—Moisture absorption data on mixtures with different quantities of manure salts and some variations in sources of nitrogen are given in Table V and Fig. 3. It is evident from series A,

TABLE III

THE INFLUENCE OF DIFFERENT QUANTITIES OF AMMONIUM NITRATE ON MOISTURE ABSORPTION BY 5–10–5 FERTILIZER

Quantity of Ammonium Nitrate Units	Moisture Content, per cent 59.4% R. H.	65.2% R. H.	72.5% R. H.
A. 1.25 units anhydrous ammonia, ammonium sulphate			
None	4.8	5.0	9.1
0.5	5.2	5.6	13.5
1.0	4.7	7.5	21.0
2.0	4.9	9.8	21.0
3.0	5.2	11.7	22.2
B. 2.8 units Nitrogen Solution-2A,[1] ammonium sulphate			
None	4.5	6.7	18.7
1.0	4.8	9.5	21.3
C. 2.25 units Urea-Ammonia Liquor-B,[2] ammonium sulphate			
None	4.5	6.6	14.5
1.0	5.2	11.2	19.0
2.0	6.0	13.6	20.6

[1]Contains 1.57 units N as ammonium nitrate.
[2]Contains 1.0 unit N as urea.

TABLE IV

THE INFLUENCE OF DIFFERENT SOURCES OF POTASH ON MOISTURE ABSORPTION BY 5–10–5 FERTILIZER

Source of Potash	Moisture Content, per cent 59.4% R. H.	65.2% R. H.	72.5% R. H.
A. No amm. nitrate, 1.25 anhydrous NH_3, 3.75 amm. sulphate			
Potassium chloride	2.7	3.2	11.2
Potassium sulphate	2.8	3.0	3.5
Sulphate of potash-magnesia	5.4	5.9	6.6
Manure salts	4.0	5.5	40.5
B. 2 units amm. nitrate, 1.25 anhydrous NH_3, 1.75 amm. sulphate			
Potassium chloride	5.0	10.0	22.0
Potassium sulphate	4.9	6.7	10.2
Sulphate of potash-magnesia	6.9	8.8	11.8
Manure salts	8.6	33.0	49.1

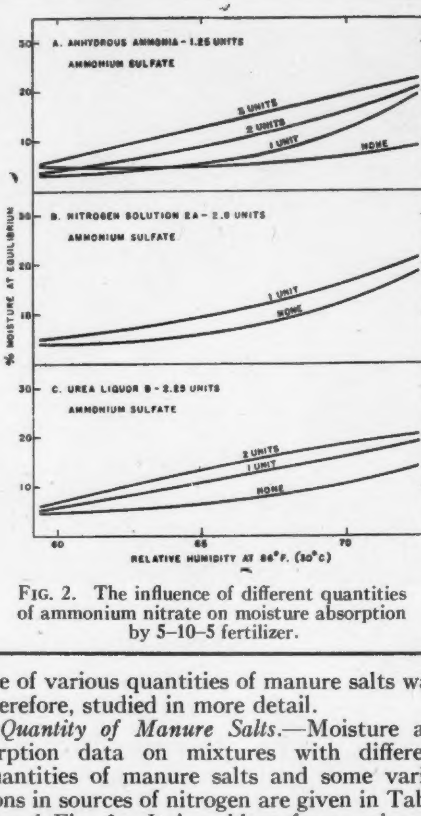

FIG. 2. The influence of different quantities of ammonium nitrate on moisture absorption by 5–10–5 fertilizer.

Cyanamid, that manure salts can be used in quantity when no hygroscopic nitrogen material is in the mixture. This confirms the data of Table IV. If, however, one unit of ammonium nitrate is introduced in a mixture containing two units of manure salts the product is moderately hygroscopic.

Series B and C give similar results except

TABLE V

THE INFLUENCE OF DIFFERENT QUANTITIES OF MANURE SALTS IN COMBINATION WITH DIFFERENT SOURCES OF NITROGEN ON MOISTURE ABSORPTION BY 5–10–5 FERTILIZER

		Moisture Content, per cent		
Manure Salts, Units	Ammonium Nitrate, Units	59.4% R. H.	65.2% R. H.	72.5% R. H.
A. 0.5 unit Cyanamid, ammonium sulphate				
0	0	2.1	2.8	17.0
1	0	2.0	3.4	25.0
2	0	1.9	3.3	30.0
2	1	5.4	13.6	33.2
B. 2.75 units Nitrogen Solution-2A,[1] ammonium sulphate				
0	0	5.0	7.1	18.8
1	0	5.1	9.9	24.8
2	0	5.5	14.2	30.2
2	1	6.5	19.0	30.6
C. 2.25 units Urea-Ammonia Liquor-B,[2] ammonium sulphate				
0	0	4.3	6.5	14.8
1	0	4.7	9.2	26.4
2	0	4.7	10.9	30.2
2	1	6.3	17.9	29.6

[1]Contains 1.54 units N as ammonium nitrate.
[2]Contains 1.0 unit N as urea.

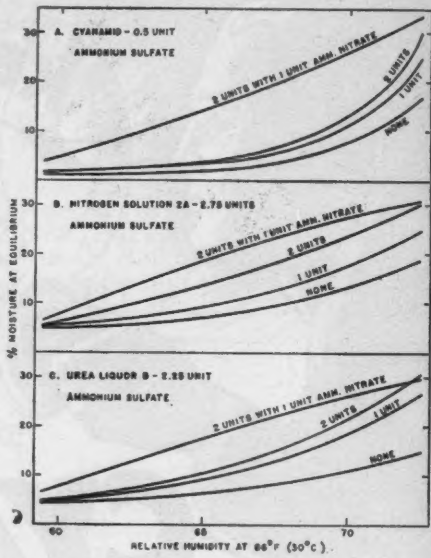

FIG. 3. The influence of different quantities of manure salts in combination with different sources of nitrogen on moisture absorption by 5–10–5 fertilizer.

the percentage moisture absorbed by series C, Urea-Ammonia Liquor-B, is usually somewhat lower than for series B. Manure salts apparently can be used with Urea-Ammonia Liquor-B to the extent of about two units of potash if there is no ammonium nitrate in the formula. On the other hand, one unit of ammonium nitrate and two units of manure salts give a quite hygroscopic mixture.

On the basis of the foregoing data the following suggestions are offered relative to formulating with manure salts:

1. As far as possible, manure salts should be used in phosphate-potash mixtures such as 0–14–7.

2. When formulating with Urea-Ammonia Liquor-B or Nitrogen Solution-2A, no more than about two units of potash from manure salts should be used. The balance of the nitrogen should be from ammonium sulphate. Practically this means using manure salts in four per cent nitrogen grades in which one-half of the nitrogen can be derived from an ammoniating solution. Solid ammonium nitrate can be used in higher nitrogen grades in which all potash is derived from muriate.

3. When formulating with Cyanamid or lime, use one unit of manure salts and one or two units of ammonium nitrate in 3 and 4 per cent nitrogen grades. In 5 and 6 per cent nitrogen grades derive all potash from muriate and use two or three units of ammonium nitrate. An alternate procedure would be to use four or five units of potash from manure salts in grades in which all the nitrogen is derived from Cyanamid and ammonium sulphate. Obviously the manure salts should be used in only low-nitrogen grades. Ammonium nitrate should be used in only those grades in which potash is derived from muriate; in such grades as much as three units of ammonium nitrate can be used.

The feasibility of adopting the suggestions depends largely on the individual manufacturer's position with respect to (a) nitrogen supplies, (b) tonnage of potash from manure salts and muriate, and (c) tonnage of various grades to be sold. The suggested procedures are not entirely satisfactory but are considered the best under the nitrogen and potash materials supply situation confronting many manufacturers.

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(To Be Continued)

THE BORON SYMPOSIUM

(Continued from page 8)

boron in the nutrient solution. A large proportion of these abnormal cells differentiated in a short time into tracheids with lignified and pitted walls when the leaves were severed from the plant and placed with the cut ends of their petioles in a solution of boric acid in pure distilled water. The same response occurred more quickly when the detached leaves were similarly placed in a solution of calcium chloride in distilled water. Distilled water and a nutrient solution minus calcium and boron did not induce this response.

A relationship between the physiological functions of calcium and boron was strongly indicated in these studies.

Supplies of oil seed meals are expected to be about the same as last year, or nearly 6,420,000 tons, according to the *Weekly Feed Market Review* of September 22nd. An increase of about 30 per cent in linseed cake and meal will total a million tons; an increase of 80 per cent in peanut oil meal and cake will make nearly 195,000 tons; soybean cake and meal will be about the same and total nearly 3,430,000 tons; while cottonseed cake and meal will be down about 10 per cent to a total of 1,800,000 tons. Including the supplies of grain by-product feeds, the grand total will be about 12½ million tons—about the same as last year but about 10 per cent less per animal unit.

PASTURE NOTES

(Continued from page 11)

porary grazing crops, like Sudan grass, oats, barley, and wheat, can be depended upon to furnish good grazing for three months each, if properly managed. Such pasture should support one cow per acre, which means that it is worth from $9 to $12 an acre monthly, or up to $36 an acre for the season, which would pay the dairyman more net profit per acre than any other crop he can grow, states E. R. Eudaly, extension dairyman.

UTAH

Meeting War Needs. Studies carried out by the Dairy Experimental Farm, George Q. Bateman, superintendent, and J. Elmo Packer, research assistant, Utah State College, show that the use of 200 pounds treble superphosphate and 6.8 tons manure per acre gave an increase of 80 standard cow days per year, or 45 per cent; nearly doubled the milk production and increased the harvested forage 95 per cent, with a gross return of $56.24 more per acre for the use of the added fertility.—The Utah Farmer, June 10, 1943.

VERMONT

Improved Pasture Cheapest Feed. In a study of the relative costs of various feeds at present, concentrates cost $3 per 100 pounds digestible nutrients; hay, $1.50 per 100 pounds; corn silage, $1.60 per 100 pounds; pasture grass, $0.71 per 100 pounds when $10 was allowed per acre for land use and only $0.36 per 100 pounds digestible nutrient when $5 was allowed for land use. A study of 100 Vermont pastures over five seasons and of feeding standards indicate that a cow making 40 pounds milk daily should be fed 1 pound grain for each 8.7 pounds milk if on excellent pasture; 1 to 4.4 if on good pasture; 1 to 2.9 if on fair pasture; and 1 to 2.2 if on poor pasture.—Vt. Sta. Pamphlet No. 1.

VIRGINIA

Fertilize Alfalfa Liberally. The annual yield of newly seeded alfalfa at the Williamsburg Branch Station was 1.19 tons hay per acre where 96 pounds of phosphorus and 64 pounds of potash were used; where 32 pounds of nitrogen were added to the above amounts the yield was 1.76 tons hay; where 128 pounds of phosphorus and 128 pounds of potash were used the uield was 1.99 tons per acre. In another test showing the importance of boron, the total yield of alfalfa hay for 3 years (1940–42) was 6.12 tons for 400 pounds 0–14–6 at seeding time; 6.67 tons for 400 pounds 0–14–6 at seeding time plus top dressing with 200 pounds each of superphosphate and muriate of potash each spring; and 12.19 tons where 10 pounds of borax were added as top dressing to the above amounts of fertilizer, reports R. P. Cocke, superintendent.

WASHINGTON

Irrigate and Manure. A two-year study of a 13-year-old bluegrass pasture shows that light irrigation produced 4,709 pounds of milk per acre; light irrigation and manuring produced 6,057 pounds; proper irrigation only 5,732 pounds; proper irrigation and manuring, 7,158 pounds. Similar results were obtained on an 8-year-old field. Cultivation reduced the returns. Top dressing of manure more than equaled proper irrigation alone, but both are essential for highest returns.

WEST VIRGINIA

Pasture Essential to Production. "Abundant pasture," points out G. Heebink, extension dairy husbandman, "stimulates milk production, cuts feed costs, reduces labor, and conserves soil." He urges farmers "to plan continuous pastures, use plenty of manure, lime, and fertilizer, rotate pastures, cut surplus growth for hay, and control weeds by regular clipping of the pastures twice each year."

BUYERS' GUIDE • A CLASSIFIED INDEX TO ALL THE ADVERTISERS IN "THE AMERICAN FERTILIZER"

This list contains representative concerns in the Commercial Fertilizer Industry, including fertilizer manufacturers, machinery and equipment manufacturers, dealers in and manufacturers of commercial fertilizer materials and supplies, brokers, chemists, etc.
For Alphabetical List of Advertisers, see page 33.

ACID BRICK
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.

ACID EGGS
Chemical Construction Corp., New York City.

ACIDULATING UNITS
Chemical Construction Corp., New York City.
Sackett & Sons Co., The A. J., Baltimore, Md.

AMMO-PHOS
American Cyanamid Co., New York City.

AMMONIA—Anhydrous
Barrett Division, The, Allied Chemical & Dye Corp., New York City.
DuPont de Nemours & Co., E. I., Wilmington, Del.
Hydrocarbon Products Co., New York City.

AMMONIA LIQUOR
Barrett Division, The, Allied Chemical & Dye Corp., New York City.
DuPont de Nemours & Co., E. I., Wilmington, Del.
Hydrocarbon Products Co., New York City.

AMMONIA OXIDATION UNITS
Chemical Construction Corp., New York City.

AMMONIATING EQUIPMENT
Sackett & Sons Co., The A. J., Baltimore, Md.

AMMONIUM NITRATE SOLUTIONS
Barrett Division, The, Allied Chemical & Dye Corp., New York City.

AUTOMATIC ELEVATOR TAKEUPS
Sackett & Sons Co., The A. J., Baltimore, Md.

BABBITT
Sackett & Sons Co., The A. J., Baltimore, Md.

BAGS AND BAGGING—Manufacturers
Bagpak, Inc., New York City.
Bemis Bro. Bag Co., St. Louis, Mo.
St. Regis Paper Co., New York City.
Textile Bag Mfrs. Association, Chicago, Ill.
Union Bag & Paper Corporation, New York City.

BAGS—Cotton
Bemis Bro. Bag Co., St. Louis, Mo.
Textile Bag Mfrs. Association, Chicago, Ill.

BAGS—Paper
Bagpak, Inc., New York City
Bemis Bro. Bag Co., St. Louis, Mo.
St. Regis Paper Co., New York City.
Union Bag & Paper Corporation, New York City.

BAGS (Waterproof)—Manufacturers
Bemis Bro. Bag Co., St. Louis, Mo.
St. Regis Paper Co., New York City.
Textile Bag Mfrs. Association, Chicago, Ill.
Union Bag & Paper Corporation, New York City.

BAGS—Dealers and Brokers
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Huber & Company, New York City.
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M., Charleston, S. C.
Wellmann, William E., Baltimore, Md.

BAG CLOSING MACHINES
Bagpak Inc., New York City.

BAGGING MACHINES—For Filling Sacks
Atlanta Utility Works, East Point, Ga.
Bagpak, Inc., New York City.
Sackett & Sons Co., The A. J., Baltimore, Md.

BAG PILERS
Link-Belt Company, Philadelphia, Chicago.

BEARINGS
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

BELT LACING
Sackett & Sons Co., The A. J., Baltimore, Md.

BELTING—Chain
Atlanta Utility Works, East Point, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

BELTING—Leather, Rubber, Canvas
Sackett & Sons Co., The A. J., Baltimore, Md.

BOILERS—Steam
Atlanta Utility Works, East Point, Ga.

BONE BLACK
American Agricultural Chemical Co., New York City
Armour Fertilizer Works, Atlanta, Ga.
Huber & Company, New York City.

BONE PRODUCTS
American Agricultural Chemical Co., New York City
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

BORAX AND BORIC ACID
American Potash and Chem. Corp., New York City.
Pacific Coast Borax Co., New York City.

BROKERS
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Dickerson Co., The, Philadelphia, Pa.
Huber & Company, New York City.
Jett, Joseph C., Norfolk, Va.
Keim, Samuel L., Philadelphia, Pa.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

BUCKETS—Elevator
Link-Belt Company, Philadelphia, Chicago
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

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BUCKETS—For Hoists, Cranes, etc., Clam Shell, Orange Peel, Drag Line, Special; Electrically Operated and Multi Power
Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.

BURNERS—Sulphur
Chemical Construction Corp., New York City.

BURNERS—Oil
Monarch Mfg. Works, Inc., Philadelphia, Pa.
Sackett & Sons Co., The A. J., Baltimore, Md.

CABLEWAYS
Hayward Company, The, New York City.

CARBONATE OF AMMONIA
American Agricultural Chemical Co., New York City.
DuPont de Nemours & Co., E. I., Wilmington, Del.

CARS—For Moving Materials
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CARTS—Fertilizer, Standard and Roller Bearing
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.

CASTINGS—Acid Resisting
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Duriron Co., Inc., The, Dayton, Ohio.

CASTINGS—Iron and Steel
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CEMENT—Acid-Proof
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.

CHAIN DRIVES—Silent
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CHAINS AND SPROCKETS
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CHAMBERS—Acid
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.

CHEMICAL APPARATUS
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Duriron Co., Inc., The, Dayton, Ohio.
Monarch Mfg. Works, Inc., Philadelphia, Pa.

CHEMICALS
American Agricultural Chemical Co., New York City.
American Cyanamid Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Barrett Division, The, Allied Chemical & Dye Corp., New York City.
Bradley & Baker, New York City.
DuPont de Nemours & Co., E. I., Wilmington, Del.
Huber & Company, New York City.

CHEMICALS—Continued
International Minerals & Chemical Corporation, Chicago, Ill.
McIver & Son, Alex. M., Charleston, S. C.
Phosphate Mining Co., The, New York City.
Wellmann, William E., Baltimore, Md.

CHEMICAL PLANT CONSTRUCTION
Atlanta Utility Works, East Point, Ga.
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CHEMISTS AND ASSAYERS
Gascoyne & Co., Baltimore, Md.
Shuey & Company, Inc., Savannah, Ga.
Stillwell & Gladding, New York City.
Wiley & Company, Baltimore, Md.

CLUTCHES
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CONCENTRATORS—Sulphuric Acid
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.

CONDITIONERS AND FILLERS
American Limestone Co., Knoxville, Tenn.
Dickerson Co., The, Philadelphia, Pa.
Phosphate Mining Co., The, New York City.

CONTACT ACID PLANTS
Chemical Construction Corp., New York City

COPPER SULPHATE
Tennessee Corporation, Atlanta, Ga.

COTTONSEED PRODUCTS
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

CRANES AND DERRICKS
Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

CYANAMID
American Agricultural Chemical Co., New York City
American Cyanamid Co., New York City.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Jett, Joseph C., Norfolk, Va.
Wellmann, William E., Baltimore, Md.

DENS—Superphosphate
Chemical Construction Corp., New York City.
Stedman's Foundry and Mach. Works, Aurora, Ind.

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MACHINERY—Power Transmission
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MACHINERY—Pumping
Atlanta Utility Works, East Point, Ga.
Duriron Co., Inc., The, Dayton, Ohio.

MACHINERY—Tankage and Fish Scrap
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MAGNETS
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MANGANESE SULPHATE
McIver & Son, Alex. M., Charleston, S. C.
Tennessee Corporation, Atlanta, Ga.

MIXERS
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

NITRATE OF SODA
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Barrett Division, The, Allied Chemical & Dye Corp., New York City.
Bradley & Baker, New York City.
Chilean Nitrate Sales Corp., New York City.
Huber & Company, New York City.
International Minerals & Chemical Corporation, Chicago, Ill.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

NITRATE OVENS AND APPARATUS
Chemical Construction Corp., New York City.

NITROGEN SOLUTIONS
Barrett Division, The, Allied Chemical & Dye Corp., New York City.

NITROGENOUS ORGANIC MATERIAL
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
DuPont de Nemours & Co., Wilmington, Del.
Huber & Company, New York City.
International Minerals & Chemical Corporation, Chicago, Ill.
McIver & Son, Alex. M., Charleston, S. C.
Smith-Rowland Co., Norfolk, Va.
Wellmann, William E., Baltimore, Md.

NOZZLES—Spray
Monarch Mfg. Works, Philadelphia, Pa.

PACKING—For Acid Towers
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.

PANS AND POTS
Stedman's Foundry and Mach. Works, Aurora, Ind.

PHOSPHATE MINING PLANTS
Chemical Construction Corp., New York City.

PHOSPHATE ROCK
American Agricultural Chemical Co., New York City.
American Cyanamid Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Coronet Phosphate Co., New York City.
Huber & Company, New York City.
International Minerals & Chemical Corporation, Chicago, Ill.
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M., Charleston, S. C.
Phosphate Mining Co., The, New York City.
Ruhm, H. D., Mount Pleasant, Tenn.
Schmaltz, Jos. H., Chicago, Ill.
Southern Phosphate Corp., Baltimore, Md.
Virginia-Carolina Chemical Corp. (Mining Dept.), Richmond, Va.
Wellmann, William E., Baltimore, Md.

PIPE—Acid Resisting
Duriron Co., Inc., The, Dayton, Ohio.

PIPES—Chemical Stoneware
Chemical Construction Corp., New York City.

PIPES—Wooden
Stedman's Foundry and Mach. Works, Aurora, Ind.

PLANT CONSTRUCTION—Fertilizer and Acid
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.

POTASH SALTS—Dealers and Brokers
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
International Minerals & Chemical Corporation, Chicago, Ill.
Jett, Joseph C., Norfolk, Va.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

POTASH SALTS—Manufacturers
American Potash and Chem. Corp., New York City.
Potash Co. of America, New York City.
International Minerals & Chemical Corp., Chicago, Ill.
United States Potash Co., New York City.

PULLEYS AND HANGERS
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

PUMPS—Acid-Resisting
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Duriron Co., Inc., The, Dayton, Ohio.
Monarch Mfg. Works, Inc., Philadelphia, Pa.

PYRITES—Brokers
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., New York City.
Wellmann, William E., Baltimore, Md.

QUARTZ
Charlotte Chem. Laboratories, Inc., Charlotte, N. C

RINGS—Sulphuric Acid Tower
Chemical Construction Corp., New York City.

ROUGH AMMONIATES
Bradley & Baker, New York City.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

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SCALES—Including Automatic Bagging
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

SCRAPERS—Drag
Hayward Company, The, New York City.

SCREENS
Atlanta Utility Works, East Point, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

SEPARATORS—Air
Sackett & Sons Co., The A. J., Baltimore, Md.

SEPARATORS—Including Vibrating
Sackett & Sons Co., The A. J., Baltimore, Md.

SEPARATORS—Magnetic
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

SHAFTING
Atlanta Utility Works, East Point, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

SHOVELS—Power
Link-Belt Company, Philadelphia, Chicago.
Link-Belt Speeder Corporation, Chicago, Ill., and Cedar Rapids, Iowa.
Sackett & Sons Co., The A. J., Baltimore, Md.

SPRAYS—Acid Chambers
Monarch Mfg. Works, Inc., Philadelphia, Pa.

SPROCKET WHEELS (See Chains and Sprockets)

STACKS
Sackett & Sons Co., The A. J., Baltimore, Md.

SULPHATE OF AMMONIA
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Barrett Division, The, Allied Chemical & Dye Corp., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
Hydrocarbon Products Co., New York City.
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

SULPHUR
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Freeport Sulphur Co., New York City.
Texas Gulf Sulphur Co., New York City.

SULPHURIC ACID
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
International Minerals & Chemical Corporation, Chicago, Ill.
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M. Charleston, S. C.

SULPHURIC ACID—Continued
U. S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.
Wellmann, William E., Baltimore, Md.

SUPERPHOSPHATE
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
International Minerals & Chemical Corporation, Chicago, Ill.
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
U. S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.
Wellmann, William E., Baltimore, Md.

SUPERPHOSPHATE—Concentrated
Armour Fertilizer Works, Atlanta, Ga.
International Minerals & Chemical Corporation, Chicago, Ill
Phosphate Mining Co., The, New York City.
U. S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.

SYPHONS—For Acid
Monarch Mfg. Works, Inc., Philadelphia, Pa.

TALLOW AND GREASE
American Agricultural Chemical Co., New York City.

TANKAGE
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
International Minerals & Chemical Corporation, Chicago, Ill.
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Smith-Rowland, Norfolk, Va.
Wellmann, William E., Baltimore, Md.

TANKAGE—Garbage
Huber & Company, New York City.

TANKS
Sackett & Sons, Co., The A. J., Baltimore, Md.

TILE—Acid-Proof
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.

TOWERS—Acid and Absorption
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.

UNLOADERS—Car and Boat
Hayward Company, The, New York City.
Sackett & Sons Co., The A. J., Baltimore, Md.

UREA
DuPont de Nemours & Co., E. I., Wilmington, Del.

UREA-AMMONIA LIQUOR
DuPont de Nemours & Co., E. I., Wilmington, Del.

VALVES—Acid-Resisting
Atlanta Utility Works, East Point, Ga.
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Duriron Co., Inc., The, Dayton, Ohio.
Monarch Mfg. Works, Inc., Philadelphia, Pa.

WHEELBARROW (See Carts)

ZINC SULPHATE
Tennessee Corporation, Atlanta, Ga.

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